Despite the implications of Motorola's sidelobe/backlobe interference problem, Motorola refuses to admit that there is a problem and has sought to stifle discussion of the issue in the international community. In order to further the study of the interference cases posed by such operation, LQSS submitted a paper to the U.S. Working Party 8D of the CCIR for presentation by the United States at the upcoming international meeting of CCIR Working Party 8D in January.[10/] Despite widespread support for this paper at the U.S.W.P. 8D meeting, from the non-geostationary applicants (other than Motorola), from AMSC and from the FAA, Motorola is attempting to block submission of this paper to the international meeting. The opposition by Motorola to exploration of this important sharing question indicates concern that the interference caused by Motorola's proposed bi-directional operation will be exposed in an international forum.

To avoid harmful interference into other systems and the construction of a self-jamming system, the Commission should not adopt the proposed secondary allocation for MSS downlinks in the L-band. If Motorola chooses to continue to pursue its application for the RDSS/MSS spectrum in light of the absence of L-band downlinks, it should be required to use the L-band for uplinks and the S-band for downlinks, like the other proposed LEO systems. See TRW Comments, at 16 n.6.

10/ This paper, USSG 8D-36, is attached as Appendix B.

VII. MOTOROLA'S PROPOSAL TO ALLOCATE THE SPECTRUM FOR A MOTOROLA MSS MONOPOLY MUST BE REJECTED.

In its Comments, Motorola repeats its claim -- which has been refuted by numerous parties in numerous prior pleadings -- that its proposed system is superior to the systems proposed by other LEO applicants. Motorola Comments, at 11-13. Motorola also argues that the Commission should grant it the exclusive, monopoly use of the 1616-1626.5 segment of the L-band and allow one other system to operate in the remaining 6 MHz of the L-band and the S-band. Id., at 16-17.

Motorola's recommendations should be rejected for several reasons. First, as LQSS has previously discussed, granting Motorola's proposed system would not advance spectrum efficiency because CDMA systems use spectrum more efficiently, making available to consumers more capacity from several systems than otherwise would be available from one system. Moreover, Motorola insists that grant of its proposal would preclude multiple entry in the RDSS/MSS bands, thereby depriving consumers of the benefits of competition, and eliminating marketplace incentives for research and development and dynamic marketplace allocation of frequency use among systems.

As discussed in Section III of the Technical Appendix, Motorola's system also appears to be not technically feasible. Motorola's bidirectional operation in the L-band would result in the generation of harmful interference through the sidelobes and backlobes of the transmitting antenna of a Motorola satellite into the receiving beams of other LEO MSS systems. The interfering

signals would also be received by other Motorola satellites in view through the sidelobes of its receiving beam. As explained in the Technical Appendix (at 14):

> With the Motorola polar orbit constellation, the distance between two adjacent satellites in different orbital planes is constantly changing. Therefore, even assuming Motorola can achieve time duplex synchronization between its satellites and the mobile terminals, it would be extremely difficult, if not impossible, to achieve L-band signal synchronization between the satellites in view in different orbital planes. Therefore, the transmitted signal from one satellite through the sidelobe of its transmit antenna would arrive at the receiving time slot of an adjacent satellite, also through the sidelobe of its receiving antenna.

The result, as explained more fully in the Technical Appendix, is that Motorola's system is self-jamming, and therefore, not technically feasible. Grant of such an application would not serve the public interest.

On the other hand, a CDMA system, such as LQSS's Globalstar, efficiently reuses spectrum, and, avoids the serious service limitations which are inherent in the design of Motorola's system. See LQSS Consolidated Oppositions to Petitions to Deny, at 9-15 (filed January 31, 1992); LQSS Consolidated Reply Comments, at 16-19 (filed March 27, 1992). As discussed in Section II of the Technical Appendix, CDMA systems permit greater channel capacity than Motorola's system and more channels per MHz. See also LQSS Consolidated Opposition to Petitions to Deny, at 10-11 (filed January 31, 1992). Moreover, Motorola's system design using intersatellite links, rather than being an advantage, results in serious signal delays for global service. Id., at 12-15. The Globalstar digital system by contrast would provide superior link

quality, less noise fading and other channel impairments than existing analog systems. Motorola's claimed "superiority" is no more than a "claim," as LQSS's technical analyses in these pleadings have demonstrated.

LQSS has also demonstrated that Motorola's band segmentation proposal would result in the loss of substantial public service benefits which could otherwise be obtained through sharing of the entire RDSS/MSS spectrum through spread spectrum CDMA techniques. See LQSS Consolidated Reply Comments, at 10-15 (filed March 27, 1992); see also Technical Appendix, at § IV. As LQSS pointed out in these comments, band segmentation would result in inefficient use of spectrum, reducing capacity for all licensed systems, and limiting service to the public.

As part of its proposal, Motorola suggests that the Commission assign the lower 6 MHz of the L-band and the S-band for LEO systems other than Iridium. This proposal must be flatly rejected. Such frequency assignment to other LEO applicants would result in unbalanced systems, forcing reductions in system capacity and requiring more complex, and consequently, more expensive, systems. Coordination with GLONASS would be more difficult due to the fact that there is no spectrum available above GLONASS-M (1620.9 MHz) into which user uplinks could be moved in order to avoid GLONASS and adjacent band interference to radioastronomy. Coordination at the domestic borders with international systems would likely require significant capacity reductions for such an unbalanced system.

Band segmentation simply does not produce feasible systems. Each licensed system must be assigned the entire L-band and S-band on a shared basis with other licensed systems. Accordingly, the Commission should reject Motorola's application and proposal in favor of band-sharing for all systems in the entire RDSS/MSS allocation and let the marketplace decide. See also TRW Comments, at 18-20; Ellipsat Comments, at 10-11.

VIII. THE COMMISSION SHOULD ADOPT WARC FOOTNOTES WHICH SUPPORT MSS ALLOCATION FOR L-BAND AND S-BAND.

The commenting parties generally support the LQSS-recommended approach with regard to United States' adoption of international footnotes that relate to use of the 1610-1626.5 MHz band in the Earth-to-space direction and the 2483.5-2500 MHz band in the space-to-Earth direction. See Ellipsat Comments, at 9-10; TRW Comments, at 20-22. Specifically, LQSS recommended adoption of International Footnote 731X which relates to the e.i.r.p. density limits applicable in the 1610-1626.5 MHz band, the power flux density limits in the 2483.5-2500 MHz band, and the application of interim coordination procedures to non-geostationary satellite systems using these frequencies.

In addition, the applicants proposing LEO systems for use of these bands agree with LQSS that the e.i.r.p. uplink density limits applicable to the 1610-1626.5 MHz bands would preclude AMSC's proposed operation in the 1616-1626.5 MHz band. See LQSS Comments, at 14-15; TRW Comments, at 16-17; Motorola Comments, at 10. Although AMSC states in its comments that it "is willing to modify its proposal for AMSC's second and third satellites" if the

Commission should decide to license multiple CDMA MSS systems in the new allocation, it nowhere provides technical detail as to how it would comply with WARC-92 footnotes such as 731X. Cf. AMSC Comments, at 19. Thus, the Commission, in adopting the proposed Footnote 731X, implicitly acknowledges that only the proposed non-geostationary satellite systems would be permitted use of the 1610-1626.5 MHz band. See LQSS Comments, at 15.

With regard to Footnote 753X, which applies the power-flux density limits of Radio Regulation 2566 to the use of the 2583.5-2500 MHz band, the Commission should reject the proposal of AMSC to utilize the PFD limit as an absolute limit, and retain the approach taken in Footnote 753X of utilizing the PFD limit as a "trigger" to determine when coordination with terrestrial systems is necessary. AMSC in fact proposes a double standard -- using the limit as an absolute for non-geostationary systems and as a trigger for geostationary systems. See AMSC Comments, Tech. App., at 9. AMSC also argues that interference from non-geostationary systems into terrestrial networks should be calculated differently than interference from geostationary systems. AMSC does not provide any technical reasons for this approach and, indeed, such an approach is not consistent with the footnote. In fact, AMSC does not address the fact that CDMA systems are likely to cause less interference to terrestrial networks as well as to other satellite systems. See LQSS Application, App. 5 (filed June 3, 1991); LQSS Comments, App. A. Consequently, AMSC's proposal with regard to Footnote 753X must be rejected.

With the exception of Motorola, all the applicants for the MSS spectrum oppose adoption of the allocation of 1613.8-1626.5 MHz in the space-to-Earth direction for the reasons discussed above in Section VI. As discussed above, the Commission should not adopt Footnote 731Y relating to secondary downlink operations in this band.

IX. THE COMMISSION SHOULD REVIEW AND CORRECT ITS INTERPRETATION OF RADIO REGULATION 2613.

LQSS, in its Comments, suggested that the Commission's interpretation of revised RR 2613 as providing that "non-geostationary satellite operations are secondary to geostationary operations in the fixed-satellite service" (Notice, ¶ 26) is not correct. LQSS Comments, at 19. Motorola, TRW and COMSAT also questioned the Commission's statement and commented that the Commission was applying too stringent an interpretation of RR 2613.

For example, Motorola asserted that its "feeder link operations will be able to coexist with GSO operations in the same bands by using certain well-recognized avoidance techniques, such as geographic, time and frequency separation." Motorola Comments, at 18. COMSAT stated flatly that "Radio Regulation No. 2613, in and of itself, will not have an effect on the availability of frequencies in the fixed-satellite service (FSS) bands for MSS low earth orbit (LEO) feeder links, as implied in paragraph 26 of the NPRM." COMSAT Comments, at 4.

These parties' comments are in harmony with LQSS's comment that situations in which non-geostationary operations must defer

to geostationary operations in the fixed-satellite service "can be identified and technical and operation measures developed to enable non-geostationary systems to adhere to the regulation." LQSS Comments, at 20; see also COMSAT Comments, at 4 ("If sharing is technically feasible, then informal coordination can take place to arrive at suitable operating arrangements to keep interference at mutually acceptable levels").

Accordingly, LQSS urges the Commission to withdraw its interpretation of RR 2613.[11/] Recognition that non-geostationary satellites can avoid interference to geostationary systems in the FSS should be sufficient.[12/]

X. THE COMMENTS DEMONSTRATE THAT THE PROPOSED LEO SYSTEMS CAN BE OPERATED WITHOUT HARMFUL INTERFERENCE INTO GLONASS AND RADIOASTRONOMY OPERATIONS.

As LQSS pointed out in its comments, Globalstar and other LEO systems will be able to coordinate successfully to avoid interference into GLONASS and radioastronomy observatories. See LQSS Comments, at 17; LQSS Application, at App. 6, § 3 (filed June 3, 1991). TRW also includes comments demonstrating that LEO

11/ LQSS does not agree with TRW that a specific footnote, addressing use of feeder links in the 20/30 GHz or any other bands, is required. A pragmatic interpretation of RR 2613, as suggested by LQSS and Motorola, is what is needed.

12/ With regard to the use of the 5150-5216 MHz band for feeder links, Constellation in its comments agreed with LQSS that, contrary to the Commission's concerns, this band is very lightly used on a world-wide basis. See Constellation Comments, at 9. As LQSS pointed out, this light use and its demonstration of procedures to avoid interference to government users in this band should allay any interference concerns, and so, this frequency should be made available for feeder links. See LQSS Comments, at 16-18.

systems using spread spectrum techniques can co-exist with both radioastronomy facilities and GLONASS. TRW Comments, at 22-24.

AMSC claims that LEO systems may have difficulty coordinating with radioastronomers and GLONASS. AMSC Comments, at 12-14, Tech. App. at 3. AMSC refers to the -15 dBW/4 kHz as "a special coordination trigger in RR731X."[13/] The coordination point is the -15 dBW/4 kHz threshold and not the interference level into a GLONASS receiver, and so, AMSC's argument must be rejected.[14/]

The -15 dBW/4 kHz level was the value agreed to by the Russian federation as the coordination level limit. Above this level then one must coordinate with GLONASS and below it there is no need to coordinate.

In addition, AMSC's comments ignore the substantial work which has already been submitted to the Commission demonstrating that such coordination is possible. See Technical Appendix, at § VI.

13/ A review of the English language version of WARC Doc. 184 (dated February 18, 1992) referenced in AMSC's Technical Appendix (§ I, at 3 n.3) reveals no mention of the uplink interference levels into a GLONASS receiver nor the desired protection ratio as stated by AMSC. In any event, WARC Doc. 184 was simply a working paper, which was not specifically adopted at WARC.

14/ Extrapolating from AMSC's calculations and its Table 1, an uplink power density of -50 dBW/4 kHz from one terrestrial MSS user located directly under the aircraft would be required to meet the permissible interference level to an unblocked aircraft at 14,500 ft. If a 10 dB fuselage blocking factor were used, the transmit EIRP density could increase to -40 dBW/4 kHz. But this does not matter, as discussed in the text.

XI. THE COMMENTS SUPPORT ADOPTION BY THE COMMISSION OF THE ANSI/ IEEE STANDARDS FOR RF RADIATION HAZARDS.

In its comments, LQSS recommended that the Commission adopt the standards for measuring RF radiation hazards established by ANSI and/or IEEE and that the Commission regulate compliance with such standards by satellite systems authorized in the new MSS allocation. LQSS Comments, at 20-21. Other parties supported these recommendations, and LQSS urges the Commission to adopt them. See Motorola Comments, at 19-21; TRW Comments, at 28.

AMSC -- which cannot provide service to handheld units -- alleges in its comments that service to handhelds by LEO systems would pose an RF hazard to users. AMSC Comments, at 21, Tech. App. at 12. AMSC's calculations are premised on the wrong type of antenna, calculated at the wrong frequencies, and use incorrect equations. See Technical Appendix, at § VII. AMSC does not even correctly analyze RF hazards in accordance with ANSI and IEEE guidelines. Because the analysis is rife with such errors, it cannot be relied on. As the commenting parties have indicated, the use of hand-held units for LEO satellite communications would not pose an RF radiation hazard.

XII. THE COMMISSION CORRECTLY REJECTED MOTOROLA'S REQUEST FOR A PIONEER'S PREFERENCE.

In its Notice, the Commission made an initial determination not to award a pioneer's preference to any of the LEO petitioners, tentatively concluding that each of them had failed to demonstrate both innovativeness and analyses necessary to show the technical feasibility of its proposal. Of the five LEO petitioners who

requested a pioneer's preference, only Motorola is presently disputing the Commission's determination.[15/] LQSS supports the Commission's determination not to grant Motorola's request for a preference.

A. Motorola Does Not Qualify for a Pioneer's Preference.

The Commission correctly concluded that Motorola's request does not meet the standard for award of a pioneer's preference. In its request, Motorola cited as innovative features of its system only its intended use of intersatellite links, spot beams, and bi-directional transmission capability. Since all these

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15/ Ellipsat (Comments, at 12), TRW (Comments, at 30 n.18), and Constellation (Comments, at 2 n.3) all indicate continuing belief that their proposed systems merit grant of their respective requests for a pioneer's preference. LQSS also contends that its request for a pioneer's preference should have been granted based on the material provided in its Request (filed November 4, 1991), Comments (filed April 8, 1992), and Supplement (filed June 12, 1992), and that the Commission's tentative decision to deny LQSS's request is incorrect with regard to the Globalstar proposal. In this regard, LQSS reserves its right to object to or to appeal this issue in the event that the Commission denies LQSS's request in the final decision in this docket.

LQSS notes that Motorola claims that the Commission erred procedurally in not allowing Motorola to comment on what it calls the expert evaluation of its request for a pioneer's preference. Motorola Comments, at 31-33 (December 4, 1992) (citing provision for public comment on expert reports in Report & Order, 6 FCC Rcd 3488, 3494 (1991)). LQSS notes that, if the Commission reconsiders Motorola's request based on this argument, LQSS should not only have the opportunity to comment on any expert evaluation of its own request (for the same reasons), and thus have its pioneer's preference request reconsidered, but also, as an interested party which filed an opposition to Motorola's request, LQSS must be given the opportunity to comment on any expert evaluation of Motorola's system in any reconsideration of Motorola's request. See Report & Order, 6 FCC Rcd at 3500 n.11 (providing for public comment on expert evaluations of requests which are formally opposed).

alleged "innovations" were developed and have been used by others, the Commission was correct in concluding that none of them "are particularly innovative or that its overall concept is unique." See Notice, ¶ 49.

In its Comments, however, Motorola contends that the Commission overlooked other allegedly innovative features of its system. Motorola Comments, at 26 n. 44 (December 4, 1992). Motorola did not mention these features of its system as justifying the award of a pioneer's preference until it filed its Supplement to Request for Pioneer's Preference (at 6-8) on April 10, 1992. The Commission accepted this late-filed Supplement, permitted others to file reply comments, and specifically referred to the Supplement in its Notice (¶ 47 n.37). It is apparent that, contrary to Motorola's assertion, the Commission did consider Motorola's supplementary material in concluding that it does not meet the standard for award of a preference. LQSS further notes that Motorola cannot properly claim that any of these features are innovative or that it is the developer of these features.

In its Comments, Motorola also refers to features of its system that are described in its "Minor Amendment", filed August 10, 1992, as innovative. Motorola Comments, at 26-27 (December 4, 1992). But that minor amendment simply reduced the number of operational satellites from 77 to 66 by eliminating one orbital plane; increased the number of spot beams associated with each satellite form 37 to 48; revised the link budget calculations; changed the intersatellite link antenna patterns; and made a few other refinements of the sort every satellite developer makes

without adding to or significantly modifying the basic technologies utilized in its system. These minor changes may reduce somewhat the enormous cost of the Iridium system, but they certainly lend no credence to Motorola's attempt to portray itself as a pioneer.

Motorola's remaining allegations are merely repetitive, or else amount to no more than a new gloss on old arguments. Motorola claims that it originated the concept of a LEO satellite system designed to provide global, mobile voice communication services, but it has previously been demonstrated that this is simply not true. See, e.g., TRW Opposition to Pioneer's Preference Request of Motorola, at 12 (filed April 8, 1992). Nor would the claim that Motorola was the first to think of the concept, even if it were true, warrant the grant of a pioneer's preference. Motorola still has not demonstrated that any of the features of its design, or the overall design, represents a pioneering achievement in technology, or that its efforts were significant in developing the technology, or that these features are technically feasible.

It has repeatedly been pointed out, and the Commission has now concluded, that the innovations claimed by Motorola as its own were in fact developed by other entities, including NASA and the Department of Defense. Notice, ¶ 49. Motorola foregoes any attempt at a factual showing that it was the party responsible for developing the claimed innovations. Instead, it argues that the prior use of these features in military satellite systems is irrelevant to the determination of whether it is a pioneer. This

argument, of course, overlooks the fact that its technologies were not only developed and in use prior to Iridium, but also were developed by entities other than Motorola.

In a similar vein, Motorola claims that the Commission's decision not to award it a preference is arbitrary in light of its decision to grant Volunteers in Technical Assistance a pioneer's reference for its proposed "little LEO" satellite system. Motorola Comments, at 29 (December 4, 1992). This argument is clearly without merit. In the "little LEO" proceeding, the Commission based its award of a pioneer's preference to VITA not only on its application for civilian purposes of technology that had been proven successful in military satellite applications, but also on the Commission's determination that VITA had been the first to develop and test several of those technologies. Tentative Decision, 7 FCC Rcd 1625, ¶ 16 (1992). In contrast, Motorola did not develop or even substantially contribute to the low-Earth orbit technology, cross-links, spot beams, on-board signal processing, bi-directional transmission, or any of the other technologies its Iridium system would employ.

B. The Grant of a Pioneer's Preference to Motorola Would be Contrary to Public Policy and Would Deprive Mutually Exclusive Applicants of Statutory Rights.

As LQSS and others have repeatedly pointed out, the award of a pioneer's preference to Motorola would be completely inconsistent with the goals of multiple use of the spectrum and open entry, and would effectively deny to mutually exclusive applicants their Ashbacker rights. See LQSS Opposition to Motorola Request for Pioneer's Preference (filed April 8, 1992).

The public interest would not be served by such a grant, as the Commission correctly decided.

XIII. CONCLUSION.

LQSS urges the Commission to adopt the recommendations discussed in its Comments and Reply Comments.

Respectfully submitted,

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TECHNICAL APPENDIX

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I. INTRODUCTION

In their comments filed December 4, 1992, Motorola and AMSC have misrepresented the potential of spread spectrum CDMA to facilitate band-sharing in the proposed MSS allocation and have incorrectly argued that their respective systems should be granted as monopoly service providers.

In these Reply Comments, LQSS reiterates that Motorola's proposed system is inferior and not superior to the systems proposed by the other LEO applicants, and indeed, that grant of Motorola's application would provide less efficient and less effective service to consumers. Similarly, AMSC's attempt to warehouse valuable spectrum for MSS would result in inefficient use of the new allocation because AMSC has not shown a need for additional spectrum and its out-of-date system cannot provide the same new and enhanced MSS services which Globalstar, and other proposed LEO systems, would provide.

The Commission should reject Motorola's and AMSC's attacks on spread spectrum CDMA as groundless. Similarly, Motorola's band-segmentation proposal must be rejected as an inefficient and unfair means to achieve multiple entry. LQSS has provided ample documentation that multiple systems employing spread spectrum CDMA would be able to share the entire proposed RDSS/MSS allocation and provide more capacity than a single system would alone.

Motorola's and AMSC's arguments have been refuted by LQSS in numerous pleadings submitted to the Commission, which are incorporated here by reference as indicated below.

II. LEO SYSTEMS USING SPREAD SPECTRUM CDMA WILL PROVIDE SUPERIOR SERVICE THROUGH HIGH CAPACITY AND SPECTRAL EFFICIENCY.

In prior pleadings, LQSS has provided substantial technical information on the use of spread spectrum CDMA by LEO satellite systems using the RDSS/MSS frequencies, as well as proof that CDMA technology works:

- Consolidated Opposition to Petitions to Deny, Tech. App. Section IX and App. C (filed January 31, 1992).
- Consolidated Reply Comments, Tech. App. Section 3 (filed March 27, 1992).
- Supplement to Request for Pioneer's Preference (filed June 12, 1992).

These discussions, which are incorporated by reference herein, have demonstrated that the use of spread spectrum CDMA would yield higher capacity than other modulation techniques and permit multiple systems to share the RDSS/MSS spectrum.

LQSS has also filed technical information which rebuts as unfounded and inaccurate attacks on the feasibility of CDMA made in papers filed by Motorola and AMSC:

- Response of Loral Cellular Systems, Corp., Affidavit of Klein Gilhousen (filed August 5, 1991).
- Consolidated Opposition to Petitions to Deny, Tech. App. Section IX and App. B (filed January 31, 1992).

These refutations are also incorporated by reference in this Technical Appendix.

With respect to the comments filed in this docket on December 4, 1992, LQSS provides the following additional information:

A. CDMA Systems Are More Efficient Than TDMA Systems.

As LQSS has pointed out before,[1/] Mobile-Satellite Systems using spread spectrum CDMA are more spectrally efficient than TDMA systems for several reasons, including:

(a) A single CDMA system permits greater frequency reuse than a TDMA system because CDMA can frequency reuse an adjacent beam and an overlapping beam while TDMA cannot.

(b) A single CDMA system alone provides more channels per MHz than a TDMA system; and,

(c) CDMA systems allow band-sharing whereas TDMA systems cannot share the same frequencies. Therefore, the frequency reuse, channel capacity, and efficiency of two or more CDMA systems may be calculated on an aggregate basis, whereas frequency reuse and channel capacity of TDMA systems cannot.

To illustrate frequency reuse, Table 1 outlines the amount of frequency reuse over CONUS for the following system proposals:

Table 1
Frequency Reuse Over CONUS

	LQSS	TRW	LQSS + TRW	Motorola
Number of Beams/CONUS	18	28	46	59
Frequency-Beam Assignment	1:1	3:1		7:1
Spectrum Reuse/CONUS	18	9.3	27.3	8.4

As indicated, the two CDMA systems, LQSS and TRW, each reuse the spectrum over CONUS more efficiently than Motorola. Moreover, because the two CDMA systems can operate using the same spectrum on a shared basis, their frequency reuse can be aggregated, making them together more than 3.2 times more efficient than Motorola. A

1/ LQSS Consolidated Opposition to Petitions to Deny (filed January 31, 1992); LQSS Consolidated Reply Comments (filed March 27, 1992); see also Appendix C attached hereto.

similar efficiency cannot be achieved by Motorola because Motorola insists that TDMA systems cannot share spectrum.[2/]

Table 2 illustrates the efficiency of these systems with respect to the L-band on a channel per MHz basis:

Table 2
Claimed CONUS Spectrum Efficiency: Channels/MHz

	LQSS	TRW	LQSS + TRW	Motorola
Requested L-Band MHz	16.5	16.5	16.5	10.5
Claimed CONUS voice capacity	6500	4600		3835
Channels/MHz	394	279	673	365

The capacity of the LQSS and TRW systems can be added because the two system designs are user uplink power limited, and not interference limited. Accordingly, the two CDMA systems operating together are about twice as efficient on a channel per MHz basis than Motorola's system operating on a monopoly basis.

B. CDMA Systems Are Superior To TDMA Systems In Interference Intensive Environments.

In its Comments, Motorola wrongly claims that "it has yet to be shown that FDMA/CDMA applicants can share spectrum on a co-frequency basis." It also mischaracterizes the ability for band-sharing among CDMA systems by noting that the other LEO applicants' systems are technically distinct and by taking out of

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2/ Motorola Consolidated Petitions to Dismiss And/or Deny and Comments, at 48 (December 18, 1991).

context a statement by LQSS that "properly designed" CDMA spread spectrum systems can share the same frequencies.[3/]

As to Motorola's first point, LQSS has demonstrated in several pleadings that spread spectrum CDMA is the best technique for multiple systems to share the same frequency, and LQSS incorporates those technical discussions by reference here.[4/] With respect to Motorola's attempt to use the diversity of the CDMA applicants to bolster its argument against CDMA, the facts simply do not support such a position. While coordination obviously improves efficiency, LQSS has also stated that "[e]ven if systems are non-homogeneous after this process, as long as they are relatively equally efficient in design, the fact that the waveforms are incompatible at the demodulators is not particularly significant. . . . CDMA is inherently an averaging technology."[5/]

By its nature, the LEO Mobile Satellite communications environment is interference-intensive. The satellites are moving, and the mobile users are also moving constantly.

To provide MSS service with LEO satellites, two different approaches have been chosen by the five applicants. Motorola selected an approach which is monopolistic in nature. The Motorola system depends on strict control of all aspects of its operation: tight synchronization in time, synchronized bi-directional transmission and reception, on-board signal processing

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3/ Motorola Comments, at 15-16 (December 4, 1992).

4/ See, e.g., LQSS Consolidated Opposition to Petitions to Deny, App. A at 48-53, and App. B (filed January 31, 1992).

5/ Id. at 53.

and intersatellite links. In a multiple international operator environment, Motorola will never be able to control other operators' systems and provide a cost-competitive service.[6/] It is not surprising, therefore, that Motorola seeks to monopolize the L-band frequency and has proposed band segmentation in this proceeding.

In sharp contrast to Motorola's proposal of highly controlled, time synchronized and cross-linked satellites, the approach of LQSS's Globalstar allows multiple systems to share the same frequency. This approach is a direct and natural extension of an approach used in digital terrestrial cellular service, using the CDMA techniques which have been verified by many field trials as more spectrally efficient than TDMA techniques.

By its nature, spread spectrum CDMA techniques allow multiple systems to share the same frequency without sub-allocation, band segmentation, or synchronization. In fact, spread spectrum CDMA is the best multiple access technique in an interference-intensive environment. In a recent article, Dr. Andrew Viterbi pointed out that "any wireless digital communication system development, whether employing satellite or terrestrial means, cannot afford to ignore the three basic lessons of Shannon's information theory."[7/]

The first two principles of Shannon's Information Theory, related to source and channel coding, have been accepted and

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6/ The Motorola system would also be self-jamming due to its bi-directional L-band approach. See Section III.

7/ A. J. Viterbi, "A Perspective on the Evolution of Multiple Access Satellite Communications," IEEE Journal on Selected Areas in Communications, Vol. 10, No. 6, August 1992 (attached hereto as Appendix D).

applied widely to digital communications system design. "[The third principle] states that the 'best' signal for the 'worst' interference will appear as wideband uniform Gaussian noise to the outside observer." Since interference, whether from one's own system or from other systems, cannot be avoided in the LEO MSS environment, the optimal solution is to employ only wideband noise-like signals. Thus, for any particular user, all interferences will appear as wideband noise, against which signal processing digital receivers are most effective. Such a wideband noise-like signal also would allow multiple systems to operate in the same frequency band without band segmentation.

The spread spectrum CDMA techniques incorporated into Globalstar are the embodiment of this principle, and these techniques represent the superior technology for LEO MSS systems. The LQSS Globalstar approach not only leads to a simpler and more cost-effective interference management, but ultimately the number of subscribers served and the quality of service provided will be increased as well.

C. Spread Spectrum CMDA Allows For Multiple Entry Contrary to the Arguments of AMSC.

AMSC claims that if all four applicants proposing to use spread spectrum CDMA attempted to operate in the same band, each would obtain very limited capacity.[8/] AMSC analyzed capacity for the downlink and the uplink and states that if all four CDMA applicants operate in the same band they will have limited

8/ AMSC Comments, at 15-16 (December 4, 1992).

capacity. It should be noted that AMSC does not provide all its calculations, showing only partial results, so it is not possible to analyze the calculations directly. However, following the assumptions and the method used in these calculations, AMSC's statement is shown to be simply wrong. Below, LQSS, following AMSC's assumptions and method, shows that the four CDMA operators can operate in the same band with no loss in planned operations capacity to Globalstar.

1. Downlink Capacity Calculation.

First, on examination of the logic of the calculations, AMSC makes numerous mistakes. For example, in the first calculation of the interfering signal power density of the four systems, AMSC states (AMSC Tech. App., at 8): "Our analysis of the associated capacity limits assumes . . . that all the systems present are operating at the RR2566 PFD level (-142/dBW/m^2/4kHz . . .) . . ., these systems will produce an interfering signal power density ("Io") level of -194 dBW/Hz . . . (excluding self-interference among downlinks in the same network)."

If four operating systems are assumed, each at the stated PFD limit, one system must be excluded because this is the system for which capacity is being calculated and self-interference excluded, according to AMSC's method. There would be then three interfering systems operating at the -142 dBW/m^2/4kHz level. The following calculation of the interfering signal power uses AMSC's assumptions: